

科目：計算機概論 適用：生醫所醫工組

編號：533

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

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Problem 1 (15 pts) In computers, we know that negative integers are represented in the 2's complement. For example, in an 8-bit system, -5 is stored as 11111011 in binary, which is calculated by inverting all bits in the 8-bit representation of 5 and finally adding 1. Explain why negative integers are not simply represented in the 1's complement (which simply negates all bits).

Problem 2 (10 pts) In the modern computer architecture, the memory access is implemented as the *memory hierarchy*. For example, there are at least DRAM, cache and hard disk within this hierarchy. Describe the mechanism of the memory hierarchy (for 5 points) and explain its design idea (for another 5 points).

Problem 3 (15 pts) In logic design, we are given two Boolean functions and want to determine whether they are identical. Let F_1 be

$$(x_3 \wedge \neg((x_1 \vee x_2) \wedge (\neg x_1 \vee \neg x_2))) \vee (\neg x_3 \wedge (x_1 \vee x_2) \wedge (\neg x_1 \vee \neg x_2))$$

and F_2 be

$$x_1 \oplus x_2 \oplus x_3$$

where \vee, \wedge, \neg and \oplus are the logical-or, the logical-and, the negation and the exclusive-or, respectively. Determine whether F_1 and F_2 are equivalent and justify your answer.

Problem 4 (15 pts) Suppose you heard an unknown topic, say "Bioinformatics," in a conference and you want to know what "BLAST" is and how it works. Describe three possible approaches that can help you solve this problem. How can each approach work? And what is the difficulty that you may face in each approach? (You can get five points for each approach if it sounds reasonable.)

Problem 5 (15 pts) *Regular expressions* can express the patterns of strings. There are at least three kinds of commonly used operations:

1. Concatenation: $R_1 R_2$ indicates choosing one string from R_1 and one from R_2 and then combining them into a new string in its order;
2. Union: $R_1 + R_2$ means that you can choose one string from either R_1 or R_2 ;
3. Star: R^* means that you can concatenate zero or more strings from R .

Suppose we have the following expression $01^*(1+0)1$ as the pattern. List all of the occurrences of this pattern in this text 01101101101111.

Problem 6 (15 pts) In the following C code,

```
int foo(char * A, char * B) {
    if (*A == '\0' || *B == '\0') return 0;
    else if (*A == *B) return 1 + foo(A+1, B+1);
    else return max(foo(A+1, B), foo(A, B+1));
}
```

the function `int max(int, int)` returns the maximum value of its arguments. Please answer the result of `foo("abbacabc", "bbcaaca")` by tracing the execution.

Problem 7 (15 pts) In the *divide-and-conquer* paradigm, we divide a big problem into smaller parts, solve each of these parts, and finally combine the partial results altogether to form the whole answer. This process is applied recursively. Show that how divide-and-conquer can be used to design an algorithm to solve the sorting problem.